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Clothier

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(54) **INTEGRAL SEALANT O-RING**

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F16B 33/00 (2006.01)
B64C 3/34 (2006.01)
F16B 5/02 (2006.01)

(52) **U.S. Cl.**
CPC ***F16B 33/004*** (2013.01); ***B64C 3/34*** (2013.01); *F16B 5/02* (2013.01)

(58) **Field of Classification Search**
CPC F16B 33/004; F16B 2013/006; F16B 5/02; F16B 17/008; F16J 15/022; B64C 3/34
See application file for complete search history.

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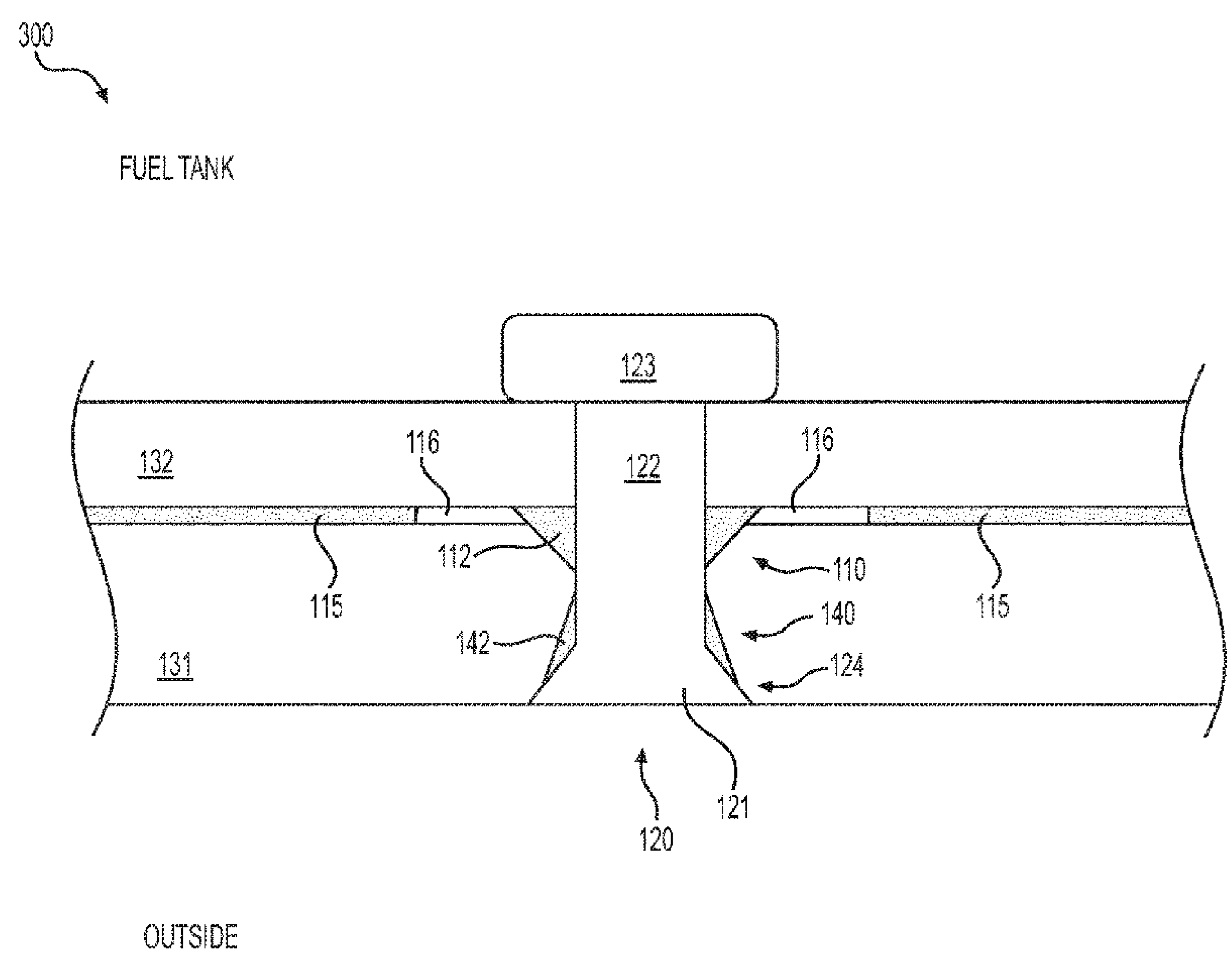
(57) **ABSTRACT**

An integral sealant O-ring for sealing fasteners in mating surfaces of a fuel tank includes a fastener hole through an inner mating surface and an outer mating surface, the fastener hole has a chamfer along a fay interface between the mating surfaces. A layer of sealant is applied along the fay interface, and upon tightening of the fastener, the inner and outer mating surfaces are pulled together squeezing the sealant into the chamfer and forming an integral sealant O-ring around the fastener. A method of forming an integral sealant O-ring includes forming a chamfer in a first mating surface substantially concentric with a fastener hole, applying a layer of sealant along the first mating surface, pulling together the first mating surface with a second mating surface by tightening a fastener to trap sealant within the chamfer for forming an integral sealant O-ring.

16 Claims, 6 Drawing Sheets



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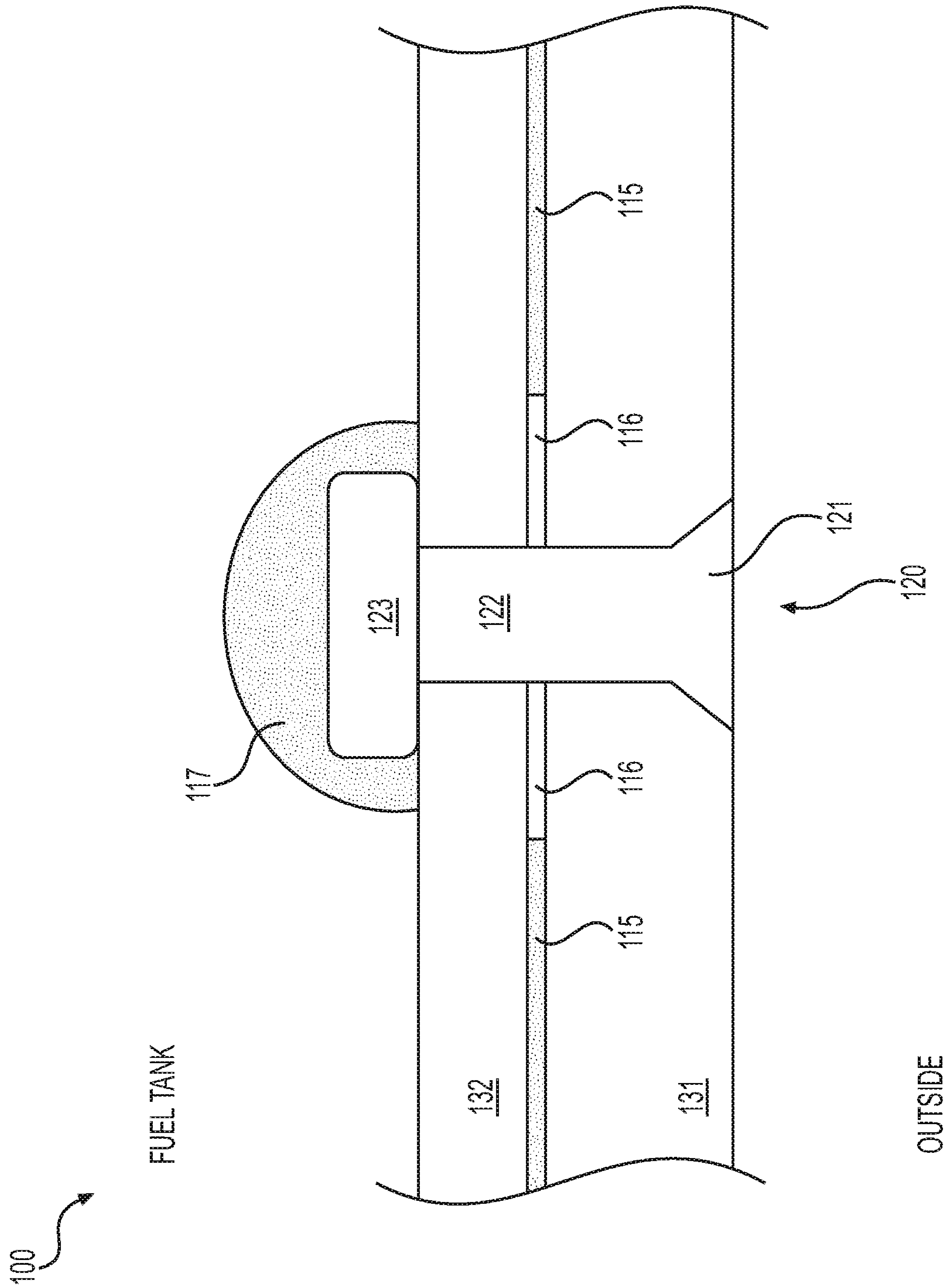

FIG. 1 (Prior Art)

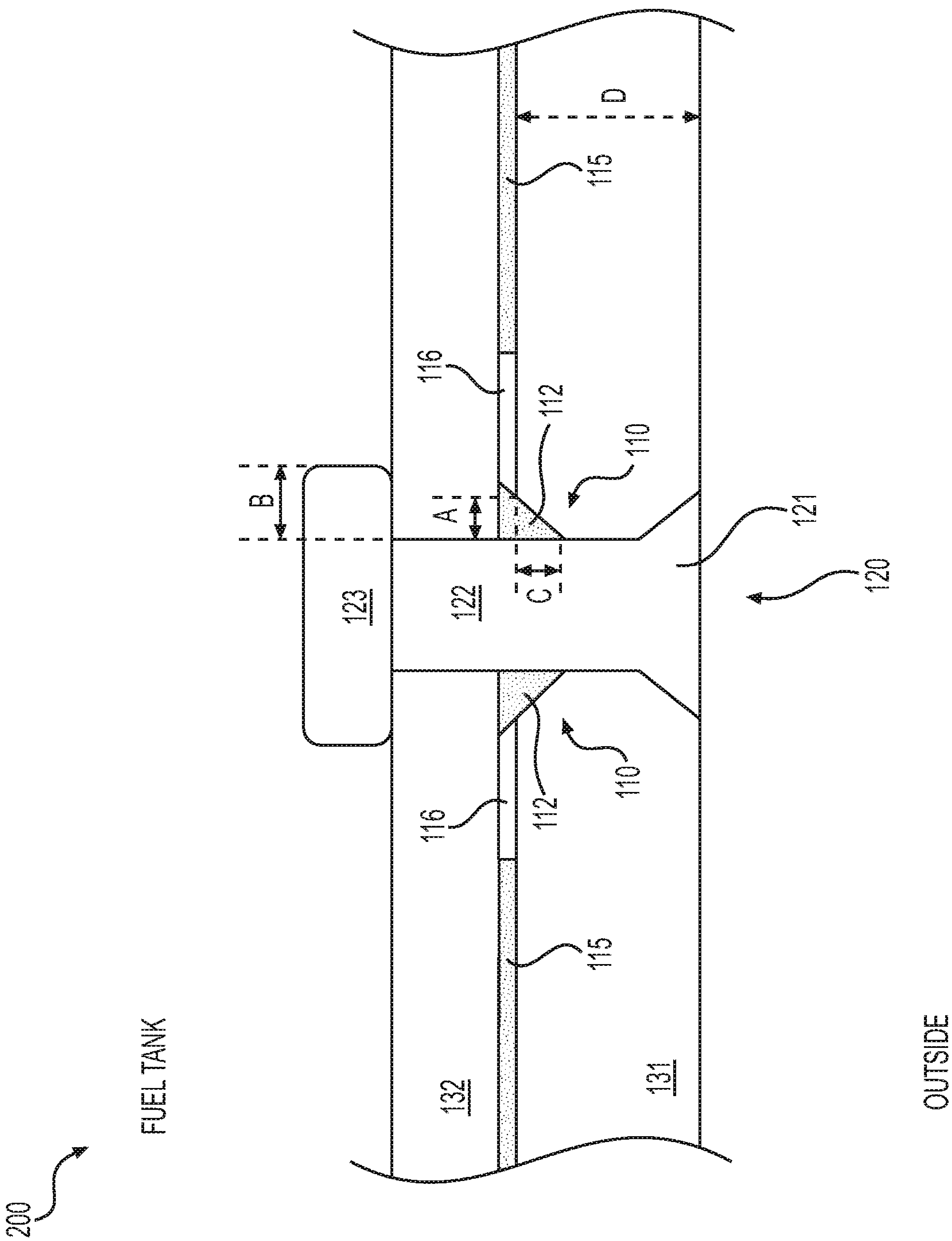
200
FUEL TANK
OUTSIDE
B
A
C
D
110
112
115
116
120
121
122
123
131
132

FIG. 2

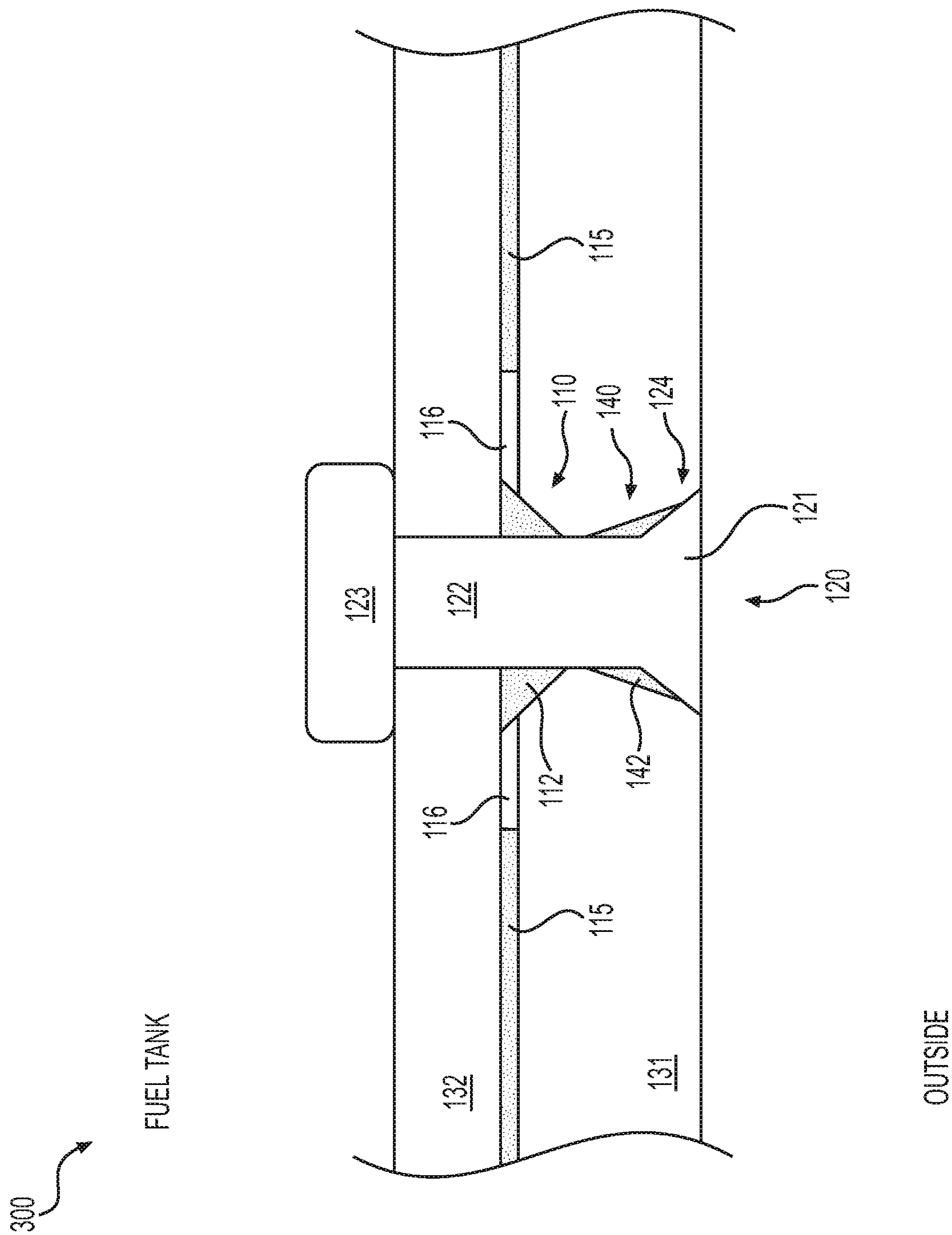
300
FUEL TANK
OUTSIDE
110
112
115
115
116
116
120
121
122
123
124
131
132
140
142

FIG. 3

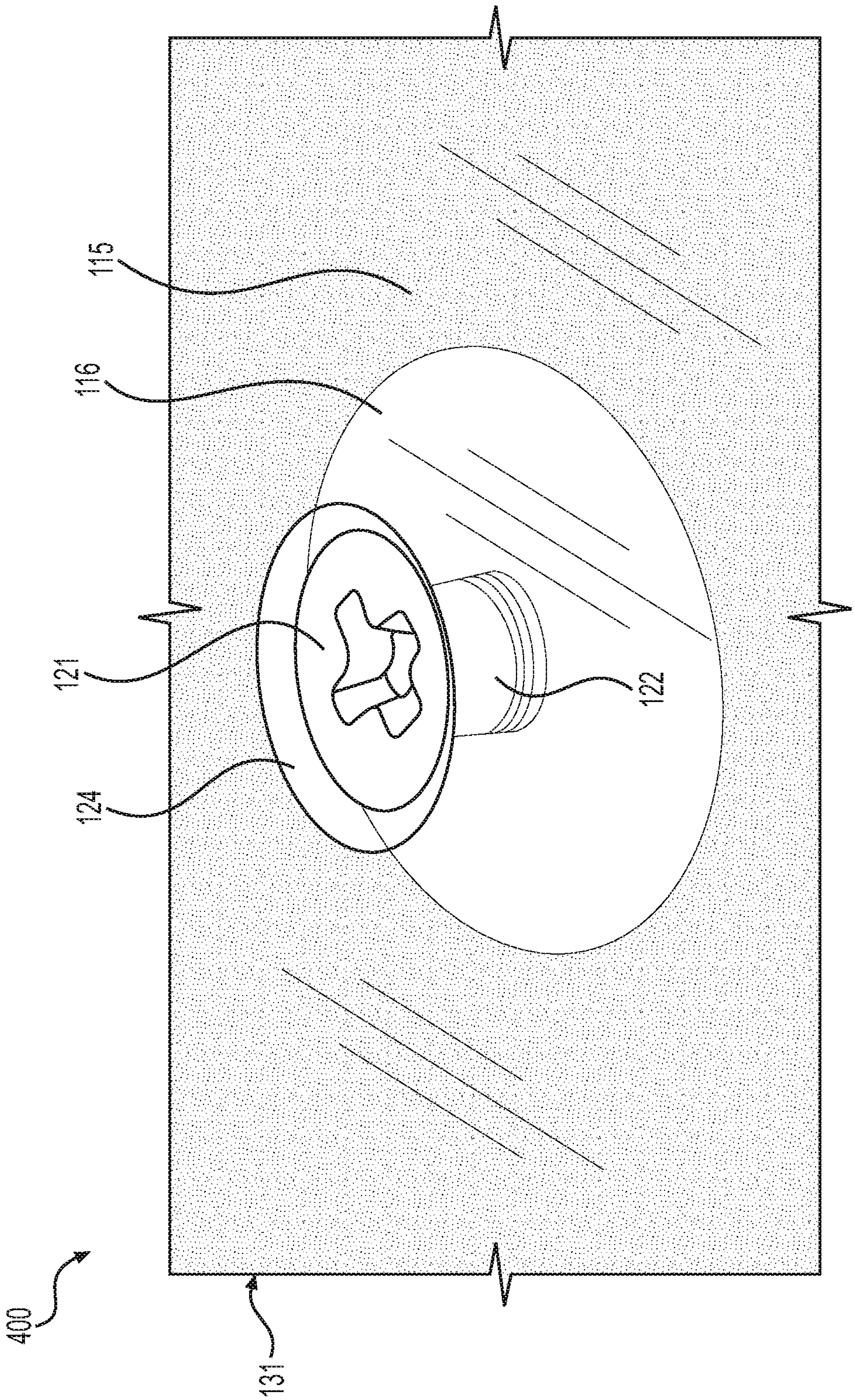

FIG. 4 (Prior Art)

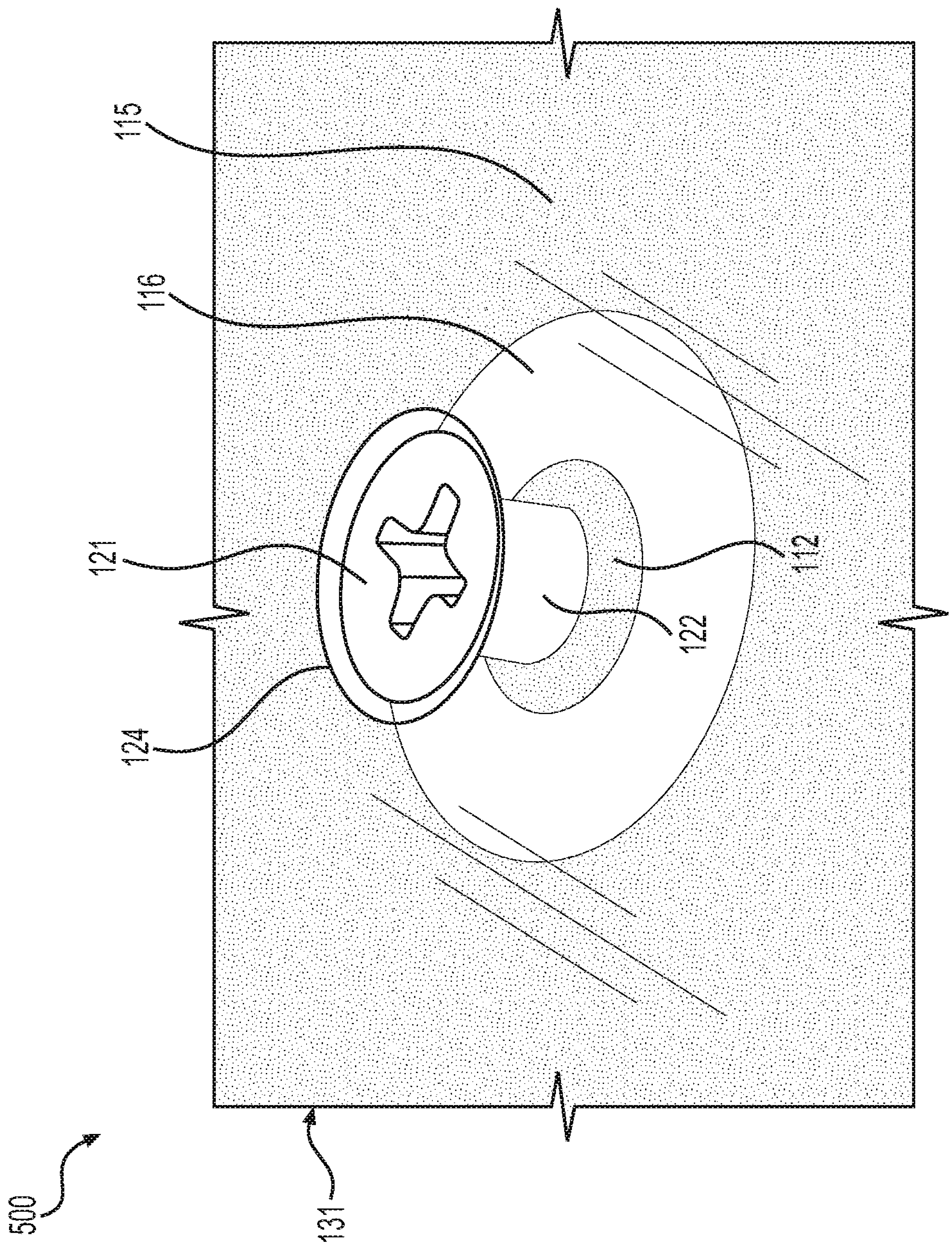

FIG. 5

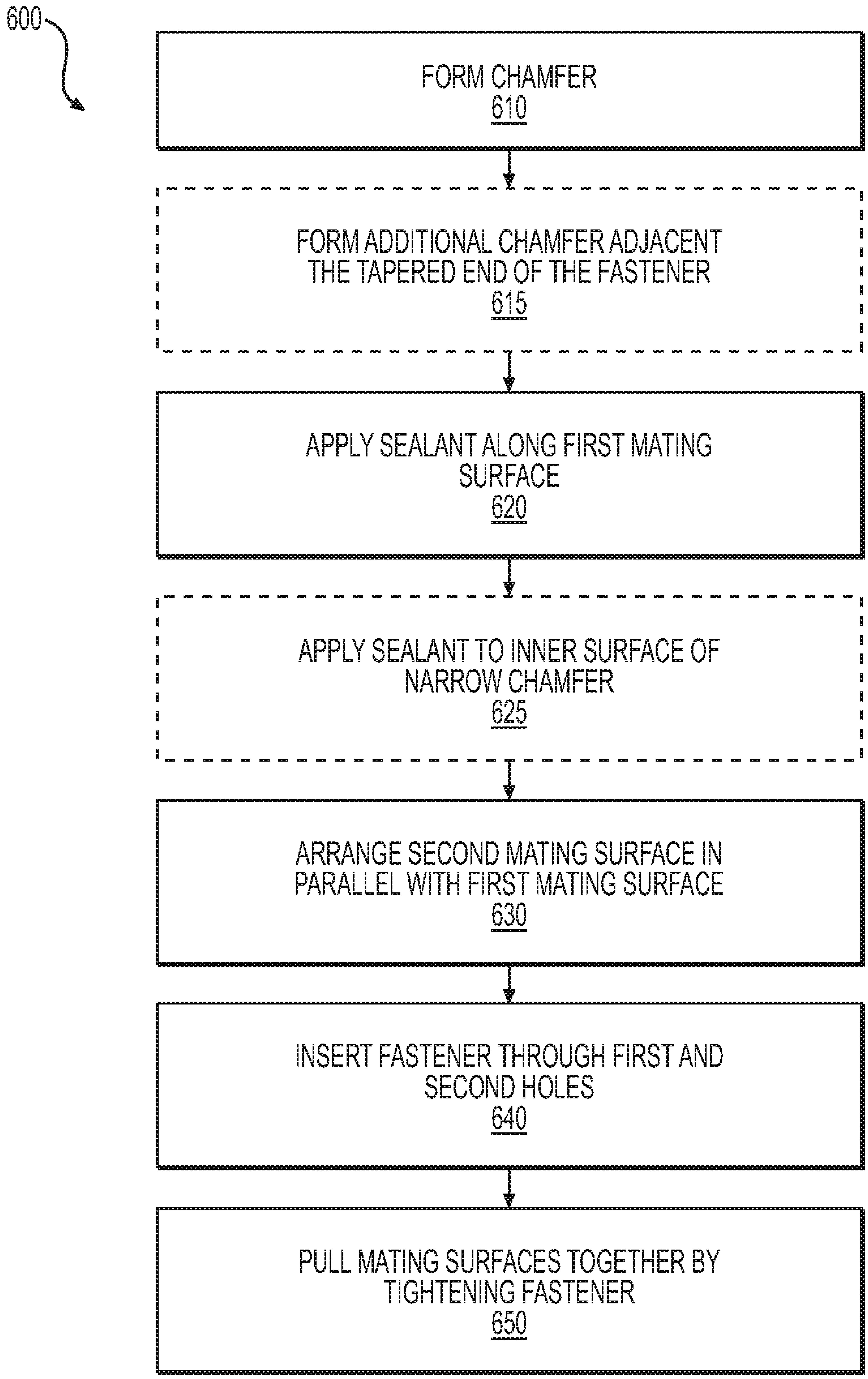
600
FORM CHAMFER
610
FORM ADDITIONAL CHAMFER ADJACENT THE TAPERED END OF THE FASTENER
615
APPLY SEALANT ALONG FIRST MATING SURFACE
620
APPLY SEALANT TO INNER SURFACE OF NARROW CHAMFER
625
ARRANGE SECOND MATING SURFACE IN PARALLEL WITH FIRST MATING SURFACE
630
INSERT FASTENER THROUGH FIRST AND SECOND HOLES
640
PULL MATING SURFACES TOGETHER BY TIGHTENING FASTENER
650

FIG. 6

INTEGRAL SEALANT O-RING

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Patent Application Ser. No. 62/659,360, entitled Integral Sealant O-Ring and filed Apr. 18, 2018, the disclosure of which is herein incorporated by reference in its entirety.

BACKGROUND

1. Field of the Disclosure

Embodiments of this disclosure relate generally to sealing fasteners, and more specifically to sealing fasteners associated with aircraft fuel tanks for preventing fuel leaks.

2. Description of the Related Art

None.

SUMMARY

In an embodiment, an integral sealant O-ring for sealing fasteners in mating surfaces of a fuel tank is provided. An inner mating surface has an inner hole for receiving a fastener. An outer mating surface has an outer hole for receiving the fastener with the outer hole being aligned with the inner hole. The fastener has a shank portion aligned through the inner hole and the outer hole and a head portion protruding adjacent the inner mating surface for tightening the fastener. A chamfer is provided around one of the inner hole or the outer hole along a fay interface between the inner mating surface and the outer mating surface. A layer of sealant is applied along the fay interface. The integral sealant O-ring is formed in the chamfer by the layer of sealant upon tightening of the fastener.

In another embodiment, a fastener seal for sealing fasteners in mating surfaces of a fuel tank is provided. An inner mating surface has an inner hole for receiving a fastener. An outer mating surface has an outer hole for receiving the fastener with the outer hole being aligned with the inner hole. The fastener has a shank portion aligned through the inner hole and the outer hole and a head portion protruding adjacent the inner mating surface for tightening the fastener. A first chamfer is provided in the outer mating surface and is adapted for receiving a tapered end of the fastener. A second chamfer, concentric with the first chamfer, has a narrower cone angle than that of the first chamfer such that a radial channel is formed around a portion of the shank and a portion of the tapered end. A layer of sealant is applied along the second chamfer such that an integral sealant O-ring is formed in the radial channel.

In yet another embodiment, a method of forming an integral sealant O-ring for sealing fasteners of mating surfaces of a fuel tank is provided. The method includes forming a chamfer in a first mating surface substantially concentric with a first hole, the first hole adapted for receiving a fastener through the first mating surface; applying a layer of sealant along the first mating surface; and arranging a second mating surface substantially in parallel with the first mating surface. The second mating surface has a second hole aligned with the first hole. The method further includes inserting the fastener through the first hole and the second hole; pulling together the first mating surface with the second mating surface by tightening the fastener, which traps a portion of the sealant within the chamfer for forming an integral sealant O-ring around a shank portion of the fastener.

BRIEF DESCRIPTION OF THE DRAWINGS

Illustrative embodiments of the present disclosure are described in detail below with reference to the attached drawing figures, which are incorporated by reference herein and wherein:

FIG. **1** is a cross-sectional side view of a prior art aircraft-wing fuel-tank fastener installation;

FIG. **2** is a cross-sectional side view of an aircraft-wing fuel-tank fastener installation having an integral sealant O-ring, in an embodiment;

FIG. **3** is a cross-sectional side view of another embodiment of an aircraft-wing fuel-tank fastener installation having an integral sealant O-ring;

FIG. **4** is a perspective view of a prior art aircraft-wing fuel-tank fastener installation;

FIG. **5** is a perspective view of an exemplary aircraft-wing fuel-tank fastener installation having an integral sealant O-ring, in an embodiment; and

FIG. **6** is a block diagram showing steps of a method for forming an integral sealant O-ring for sealing fasteners of mating surfaces of a fuel tank, in an embodiment.

DETAILED DESCRIPTION

For aircraft fuel tanks that have a "wet wing" configuration, meaning that no bladder is used to contain fuel within the wing, special means are needed to prevent leaking of fuel especially along fasteners of the fuel-tank/wing surfaces. Standard practice for sealing fuel-tank fasteners is to apply a fay and fillet seal to mating surfaces of the wing structure and a daub seal to a wet end of each fastener protruding into the fuel tank.

FIG. **1** is a cross-sectional side view of a prior art aircraft-wing fuel-tank fastener installation **100**. Dimensions in the figures are not drawn to scale. Mating surfaces of an aircraft wing structure often include a first surface fastened to a second surface. For example, as depicted in FIGS. **1-3**, the first surface is an outer surface **131** and the second surface is an inner surface **132**. Outer and inner surfaces **131**, **132** may be made of sheet metal, for example, and are aligned substantially parallel with one another in a transverse direction. Outer surface **131** has an inner side adjacent inner surface **132** and an outer side opposite the inner side. Inner surface **132** has an inner side that is exposed to fuel within a bladderless fuel tank and an outer side adjacent outer surface **131**. Outer surface **131** may be an outer wing surface with its outer side exposed to air outside of the aircraft. The interface between the inner side of outer surface **131** and outer side of the inner surface **132** is known as a "fay interface".

A fastener **120** is used to pull outer surface **131** and inner surface **132** together along the fay interface such that the inner side of outer surface **131** mates flush with the outer side of inner surface **132**. In practice, a plurality of fasteners are used to pull the mating surfaces together; however, only one fastener is described and depicted in the figures for clarity of illustration. Fastener **120** is for example a rivet or HI-LOK™ pin (Lisi Aerospace, Paris, France). A shank portion **122** of fastener **120** passes through aligned holes of the mating surfaces in a longitudinal direction, substantially perpendicular to the transverse direction. Specifically, a first hole is drilled through outer surface **131** and a second hole is drilled in a matching location through inner surface **132**.

A sealant **115** is placed along the fay interface, between outer surface **131** and inner surface **132**, prior to pulling the surfaces together. An example of sealant **115** is 3M™ Aerospace Sealant AC-350 (3M, Maplewood, Minn.). Sealant **115** forms a fay seal intended to prevent fuel from seeping along the fay interface and contacting shank portion **122**, where it may seep along shank portion **122** and leak outside. The problem with fay seals is that they are not completely reliable because sealant **115** is pressed away from shank portion **122** as the mating surfaces (e.g., outer and inner surfaces **131**, **132**) are pulled together leaving a gap **116** having little or no sealant directly around shank portion **122**. Gap **116** lacking sealant provides a potential path for fuel to leak along shank portion **122**, especially if there is a flaw in one of the mating surfaces along the fay interface.

A fillet seal may be applied around the edge of a head portion **123** of fastener **120**, but application of a fillet seal is laborious. In practice, a daub seal **117** is applied to head portion **123** of fastener **120**, as depicted in FIG. **1**. To improve task efficiency, excess sealant is applied to daub seal **117**, which may result in up to approximately seventy-five percent of the sealant applied being unnecessary. Therefore, daub seal **117** adds weight to the aircraft (in the form of excess sealant) and also requires labor in addition to applying a fay seal.

Embodiments of the present disclosure provide a chamfer for receiving sealant around a fastener, which forms an integral sealant O-ring around a shank portion of the fastener adjacent a fay interface. Advantages include improved prevention of fuel leakage from a wet wing aircraft while eliminating the need for a daub seal applied to the fastener.

FIG. **2** is a cross-sectional side view of an exemplary aircraft-wing fuel-tank fastener installation **200**. Mating surfaces of the aircraft-wing structure are the same as FIG. **1**, namely outer surface **131** and inner surface **132**. In certain embodiments, outer surface **131** is an outer wing surface with its outer side exposed to air outside of the aircraft.

As depicted in FIG. **2**, an exemplary fastener **120** is a countersunk bolt having a tapered end **121** flush with the outer side of outer surface **131**. Shank portion **122** of fastener **120** passes through a first hole of outer surface **132** and a second hole of inner surface **132**, and head portion **123** is adjacent the inner side of inner surface **132**. Head portion **123** is for example a rivet head or a threaded nut for tightening along corresponding threads of shank portion **122**. Once tightened, outer surface **131** and inner surface **132** squeeze sealant away from shank portion **122** forming gap **116**, as further described below in connection with FIG. **4**. Head portion **123** is also referred to as the wet end of fastener **120** since it gets wet from fuel when fuel is present in the fuel tank. An improperly sealed fastener **120** is susceptible to wicking or seeping of fuel along and under head portion **123** and along shank portion **122** to the outer side of outer surface **131**.

As depicted in FIG. **2**, a chamfer **110** is provided along the fay interface and around the fastener hole in outer surface **131**. However, chamfer **110** may be provided along the fay interface in either outer surface **131** or inner surface **132** as further described below in connection with step **610**, FIG. **6**.

Sealant **115** is applied to the fay interface as further described below in connection with step **620**, FIG. **6**. Sealant **115** fills chamfer **110** such that sealant **115** forms a ring around shank portion **122**. Outer surface **131** and inner surface **132** are pulled together via fastener **120**, as further described below in connection with step **650**, FIG. **6**. A portion of the sealant remains trapped around in chamfer **110** despite sealant being squeezed away from shank portion **122** along the fay interface forming gap **116**. In other words, integral sealant O-ring **112** is an O-ring made of sealant **115** that is integrally formed around shank portion **122** in chamfer **110** along the fay interface of the mating surfaces, as depicted in FIG. **2**. The resulting integral sealant O-ring **112** obviates the need for performing a secondary operation of applying daub seal **117** to head portion **123**, as depicted in FIG. **1**.

Chamfer **110** is formed in a fay surface around a fastener hole as part of the process of drilling the fastener hole. Exemplary drilling processes used to form chamfer **110** are described below in connection with step **610**, FIG. **6**. Fastener **120** is preferably cleaned prior to installation in outer and inner surfaces **131**, **132** to avoid contamination, which may inhibit sealant **115** from adhering to shank portion **122**, as further described below in connection with step **640**, FIG. **6**.

As depicted in FIG. **2**, chamfer **110** forms a maximum width "A" around shank portion **122** and a maximum depth "C" into outer surface **131**, where outer surface **131** has a thickness "D". The diameter of head portion **123** is such that it overlaps shank portion **122** in a radial direction by a distance "B". In certain embodiments, width A of chamfer **110** is less than or equal to half of distance B, and depth C is less than or equal to half of thickness D. A cone angle of chamfer **110** may be within the range of fifteen to sixty degrees and preferably about forty-five degrees with respect to the longitudinal direction of the shank portion. Chamfer **110** may have straight or curved walls without departing from the scope hereof.

FIG. **3** is a cross-sectional side view of an exemplary aircraft-wing fuel-tank fastener installation **300**. Fastener installation **300** is an example of fastener installation **200**, FIG. **2** having an additional integral sealant O-ring **142** formed around a portion of fastener **120**. Specifically, integral sealant O-ring **142** is formed around part of shank portion **122** adjacent tapered end **121** and around a portion of tapered end **121**. Integral sealant O-ring **142** may be used in place of integral sealant O-ring **112** or in combination with integral sealant O-ring **112** as depicted in FIG. **3**.

Integral sealant O-ring **142** may be formed by adding a narrow chamfer **140** to a wide chamfer **124**. Wide chamfer **124** is adapted for accepting tapered end **121** of fastener **120**. Narrow chamfer **140** may be added by drilling with a countersink drill as described below in connection with optional step **615**, FIG. **6**. Narrow chamfer **140** provides a radial channel around shank portion **122** above tapered end **121**. As described below in connection with optional step **625**, the radial channel may be filled with sealant prior to insertion of fastener **120** such that an integral sealant O-ring **142** is formed in the radial channel for preventing fuel seepage from the fuel tank along fastener **120** to the outside.

FIG. **4** is a perspective view of a prior art aircraft-wing fuel-tank fastener installation **400**. In FIGS. **4** and **5**, outer surface **131** is depicted as a transparent material (e.g., an acrylic block) for demonstration purposes only such that sealant **115** may be viewed along the fay interface with inner surface **132**. Shaft **122** is visible through the transparent outer surface **131**.

In the prior art installation **400**, a gap **116** in sealant **115** forms around shank portion **122** upon tightening of the fastener. In other words, as outer surface **131** and inner surface **132** are squeezed tightly together, sealant **115** is compressed near the fastener. Since the portions of the mating surfaces closest to the fastener are squeezed together the tightest by the fastener, the area immediately surrounding the fastener tends to be evacuated of sealant **115** forming gap **116**. Gap **116** leaves an unsealed area around shank portion **122** providing a potential path for fuel to leak along the fastener from inside the fuel tank.

FIG. **5** is a perspective view an exemplary aircraft-wing fuel-tank fastener installation **500** having an integral sealant O-ring **112**. The O-ring **112** is formed of sealant that fills in a chamfer around shank portion **122** at the fay interface. The chamfer may be added to either the inner surface **132** or the outer surface **131**. After applying sealant along the fay interface, the fastener is tightened, and sealant **115** remains trapped in the chamfer such that gap **116** is separated from the shank portion **122** by the integral sealant O-ring **112**. In this manner, the fastener is sealed preventing fuel from leaking along the fastener.

FIG. **6** is a block diagram showing steps of a method **600** for forming an integral sealant O-ring for sealing fasteners of mating surfaces of a fuel tank. The method may be used during manufacture to install fastener installation **200**, FIG. **2**. Optional steps of the method may be used to install fastener installation **300**, FIG. **3**, as described below.

In a step **610**, a chamfer is formed in a first mating surface. The chamfer is formed substantially concentric with a first hole through the first mating surface adapted for receiving a fastener. For example, after the first hole is drilled with a standard drill bit, the chamfer is drilled into an outer portion of the first hole using a countersink drill bit. Alternatively, the hole and chamfer may both be drilled in one pass using an all-in-one type of countersink drill bit. Drilling of the first hole and the chamfer are preferably performed without lubrication (e.g., without BOELUBE®) to provide a clean surface for sealant adhesion. In an example of step **610**, chamfer **110** is formed in outer surface **131** along the fay interface, as depicted in FIG. **2**. In some embodiments, chamfer **110** is instead formed in inner surface **132** (not shown). In other words, integral sealant O-ring **112** may be formed along the fay interface in either outer surface **131** or inner surface **132** without departing from the scope hereof.

In an optional step **615**, an additional integral sealant O-ring may be formed around the shank portion of the fastener adjacent the tapered end. In an example of optional step **615**, additional integral sealant O-ring **142** is formed around shank portion **122** adjacent tapered end **121**, as depicted in FIG. **3** and described above. Narrow chamfer **140** may be added by drilling with a countersink drill bit having a narrower cone angle compared to that used to form wide chamfer **124**. For example, wide chamfer **124** may have a cone angle of about forty-five degrees and narrow chamfer **140** may have a cone angle of about thirty degrees with respect to shank portion **122**. However, narrow chamfer **140** may be formed with any cone angle narrower than wide chamfer **124** so long as the bearing area of fastener **120** (i.e., the unchamfered portion of the fastener hole around shank portion **122**) is reduced by less than fifty percent, including the reduction of the bearing area of fastener **120** due to chamfer **110**. When a fastener is inserted in step **640**, narrow chamfer **140** provides a radial channel around a portion of tapered end **121** and around shank portion **122** adjacent tapered end **121**.

In a step **620**, sealant is applied along a first mating surface. In an example of step **620**, sealant **115** is disposed along the fay interface prior to pulling the first mating surface together with a second mating surface. In certain embodiments, sealant may be applied to either or both of the first and second mating surfaces. An example of sealant **115** is 3M™ Aerospace Sealant AC-350 (3M, Maplewood, Minn.). Sealant **115** forms a fay seal intended to prevent fuel from seeping along the fay interface.

In an optional step **625**, sealant is applied to an inner surface of a narrow chamfer prior to insertion of the fastener to form an integral sealant O-ring. In an example of optional step **625**, sealant is applied along the inside of narrow chamfer **140** prior to insertion of fastener **120**.

In a step **630**, a second mating surface is arranged substantially parallel with the first mating surface, and a second hole through the second mating surface is aligned with the first hole through the first mating surface. In an example of step **630**, outer surface **131** is arranged substantially parallel with inner surface **132**, and the first hole through outer surface **131** is aligned with the second hole through inner surface **132**.

In a step **640**, a fastener is inserted through the first hole and the second hole. In an example of step **640**, fastener **120** is inserted through the first hole of outer surface **131** and the second hole of inner surface **132**. In certain embodiments, the fastener is cleaned prior to inserting through the fastener holes to ensure proper adhering of the sealant with the shank portion of the fastener. For example, a simple rotary cleaning station may be provided at a wing assembly station to enable cleaning of fasteners immediately prior to installation. Clean fasteners are preferably handled by a gloved operator (e.g., wearing white cotton gloves commonly used in manufacturing operations) to prevent contamination during installation. In embodiments having a narrow chamfer **140**, an additional integral sealant O-ring **142** is formed in a radial channel around shank portion **122** at tapered end **121** to prevent fuel seepage from the fuel tank along shank portion **122** to the outside.

In a step **650**, first and second mating surfaces are pulled together by tightening at least one fastener. In practice, a plurality of fasteners are used to pull the mating surfaces together; however, only one fastener is described and depicted in the figures for clarity of illustration. Tightening of the fastener(s) traps a portion of the sealant within the chamfer for forming an integral sealant O-ring around a shank portion of the fastener. In an example of step **650**, outer surface **131** is pulled together with inner surface **132** by tightening fastener **120**, which compresses the sealant layer trapped in chamfer **110** for forming integral sealant O-ring **112** around shank portion **122**.

By using method **600**, fuel leakage is prevented from a wet wing aircraft by forming the integral sealant O-ring along the shank portion of the fastener. Advantages include improved reliability, reduced labor associated with applying a fillet seal around the edge of a head portion of the fastener, and reduced labor and sealant associated with applying a daub seal to the head portion of the fastener.

Many different arrangements of the various components depicted, as well as components not shown, are possible without departing from the spirit and scope of the present disclosure. Embodiments of the present disclosure have been described with the intent to be illustrative rather than restrictive. Alternative embodiments will become apparent to those skilled in the art that do not depart from its scope. A skilled artisan may develop alternative means of implementing the aforementioned improvements without departing from the scope of the present disclosure.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations and are contemplated within the scope of the claims. Not all operations listed in the various figures need be carried out in the specific order described.

The invention claimed is:

1. A sealing assembly for sealing fasteners in mating surfaces of a fuel tank, comprising:

an inner mating surface having an inner hole for receiving a fastener;

an outer mating surface having an outer hole for receiving the fastener, the outer hole being aligned with the inner hole;

the fastener having a shank portion aligned through the inner hole and the outer hole and a head portion protruding adjacent the inner mating surface for tightening the fastener;

a first chamfer in an outer side of the outer mating surface adapted for receiving a tapered end of the fastener;

a second chamfer in an inner side of the outer mating surface, the second chamfer being around the inner hole and along a fay interface between the inner mating surface and the outer mating surface;

a layer of sealant applied along the fay interface; and

an integral sealant O-ring formed in the second chamfer by the layer of sealant upon tightening of the fastener.

2. The sealing assembly of claim **1**, wherein a width of the second chamfer is less than or equal to half of a distance that the head portion overlaps the shank portion.

3. The sealing assembly of claim **1**, wherein a depth of the second chamfer is less than or equal to half of a thickness of the inner mating surface.

4. The sealing assembly of claim **1**, wherein a cone angle of the second chamfer is between about fifteen degrees to about sixty degrees with respect to a longitudinal direction of the shank portion.

5. The sealing assembly of claim **1**, wherein the integral sealant O-ring prevents fuel leakage from a wet wing aircraft along the shank portion of the fastener without a daub seal applied to the head portion of the fastener.

6. An aircraft sealing assembly for sealing fasteners in mating surfaces of a fuel tank, comprising:

an inner mating surface having an inner hole for receiving a fastener;

an outer mating surface having an outer hole for receiving the fastener, the outer hole being aligned with the inner hole;

the fastener having a shank portion aligned through the inner hole and the outer hole and a head portion protruding adjacent the inner mating surface for tightening the fastener;

a first chamfer in the outer mating surface adapted for receiving a tapered end of the fastener;

a second chamfer, concentric with the first chamfer, the second chamfer having a narrower cone angle than that of the first chamfer such that a radial channel is formed around a portion of the shank and a portion of the tapered end; and

a layer of sealant applied along the second chamfer such that an integral sealant O-ring is formed in the radial channel.

7. The aircraft sealing assembly of claim **6**, wherein a cone angle of the first chamfer has a wider cone angle than the second chamfer.

8. The aircraft sealing assembly of claim **7**, wherein a cone angle of the first chamfer is about forty-five degrees and a cone angle of the second chamfer is about thirty degrees.

9. The aircraft sealing assembly of claim **6**, wherein a bearing area of the fastener **120** is reduced by less than fifty percent due to the second chamfer.

10. The aircraft sealing assembly of claim **6**, wherein the integral sealant O-ring prevents fuel leakage from a wet wing aircraft along the shank portion of the fastener without a daub seal applied to the head portion of the fastener.

11. The aircraft sealing assembly of claim **6**, further comprising a third chamfer in one of the inner mating surface or the outer mating surface along a fay interface therebetween, wherein sealant applied along the fay interface forms an additional integral sealant O-ring in the third chamfer upon tightening of the fastener.

12. A sealing assembly for sealing fasteners in mating surfaces of an aircraft fuel tank, comprising:

an inner mating surface having an inner hole for receiving a fastener;

an outer mating surface having an outer hole for receiving the fastener, the outer hole being aligned with the inner hole;

the fastener having a shank portion aligned through the inner hole and the outer hole and a head portion protruding adjacent the inner mating surface for tightening the fastener;

a first chamfer in an outer side of the outer mating surface adapted for receiving a tapered end of the fastener;

a second chamfer in an inner side of the outer mating surface, the second chamfer being around the outer hole and along a fay interface between the inner mating surface and the outer mating surface;

a third chamfer in the outer side of the outer mating surface, concentric with the first chamfer, the third chamfer having a narrower cone angle than that of the first chamfer such that a radial channel is formed around a portion of the shank and a portion of the tapered end;

a layer of sealant applied along the fay interface; and

an integral sealant O-ring formed in the second chamfer and the third chamfer by the layer of sealant upon tightening of the fastener.

13. The sealing assembly of claim **12**, wherein a width of the second chamfer is less than or equal to half of a distance that the head portion overlaps the shank portion.

14. The sealing assembly of claim **12**, wherein a depth of the second chamfer is less than or equal to half of a thickness of the outer mating surface.

15. The sealing assembly of claim **12**, wherein a cone angle of the second chamfer is between about fifteen degrees to about sixty degrees with respect to a longitudinal direction of the shank portion.

16. The sealing assembly of claim **12**, wherein the integral sealant O-ring prevents fuel leakage from a wet wing aircraft along the shank portion of the fastener without a daub seal applied to the head portion of the fastener.

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